



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

### Usage guidelines

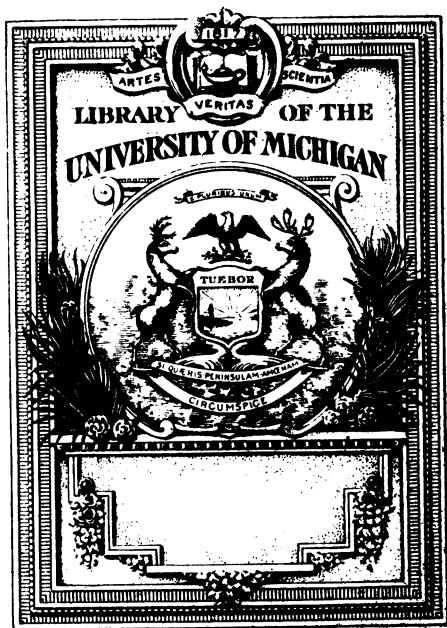
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

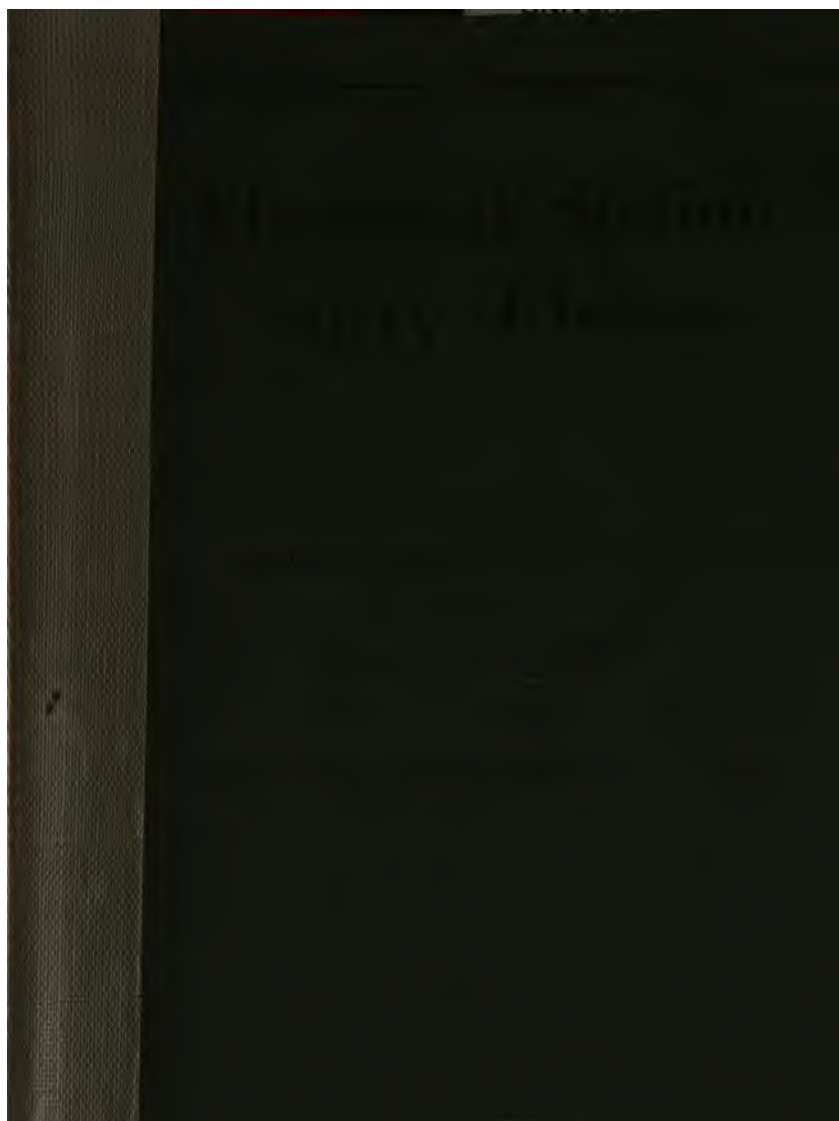
We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

### About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>







TK  
152  
.C2  
1918

# Electrical Station Safety Orders

Issued by the

Industrial Accident Commission

of the

State of California

**EFFECTIVE DECEMBER 1, 1918**

---

California State Printing Office  
Sacramento  
1918

**INDUSTRIAL ACCIDENT COMMISSION  
OF THE STATE OF CALIFORNIA**

**525 Market Street, San Francisco  
423 Union League Building, Los Angeles**

**A. J. PILLSBURY, Chairman.**

**WILL J. FRENCH,**

**MEYER LISSNER,**

**Commissioners.**

**JOHN R. BROWNELL,**  
**Superintendent of Safety.**



**SUMMARY OF THE SAFETY PROVISIONS  
of the**

**Workmen's Compensation, Insurance and Safety Act.**

Being Chapter 176 of the Laws of 1913 as Amended by Chapter 607 of the Laws of 1915, and Chapter 586 of the Laws of 1917.

Sections 33 to 54, inclusive, of the Workmen's Compensation, Insurance and Safety Act give the Industrial Accident Commission power to make and enforce safety orders, rules and regulations, to prescribe safety devices, and to fix safety standards. It also empowers the Commission to appoint advisors who shall, without compensation, assist the Commission in establishing standards of safety. The Commission may adopt and incorporate in its general orders such safety recommendations as it may receive from such advisors.

The Commission, carrying out its plan of obtaining the best practical ideas to incorporate in its Safety Orders, asked various interests to serve on a committee to draft Electrical Station Safety Orders.

**COMMITTEE ON ELECTRICAL STATION SAFETY ORDERS :**

- J. P. JOLLYMAN (chairman), engineer of electrical construction, Pacific Gas and Electric Company, representing the National Electric Light Association, San Francisco.
- J. A. LIGHTHIPE, electrical engineer, Southern California Edison Company, representing the National Electric Light Association, Los Angeles.
- J. A. KOONTZ, electrical engineer, Great Western Power Company, representing the National Electric Light Association, San Francisco.
- M. C. MCKAY, general superintendent, Sierra & San Francisco Power Company, representing the National Electric Light Association, San Francisco.
- WALTER T. BIVINS, chief engineer electrical equipment, United Railroads of San Francisco, representing the California Electric Railway Association, San Francisco.
- S. H. ANDERSON, electrical superintendent, Pacific Electric Railway, representing the California Electric Railway Association, Los Angeles.
- R. H. MANAHAN, city electrician, City of Los Angeles, representing the League of California Municipalities, Los Angeles.

- ARTHUR KEMPSTON, chief, department of electricity, City of San Francisco, representing the League of California Municipalities.
- R. T. JOSLIN, engineering department, representing the Pacific Telephone & Telegraph Company, San Francisco.
- J. C. FRICKE, representing the Western Union Telegraph Company, San Francisco.
- H. C. SHAW, division electrical engineer, representing the Postal Telegraph Cable Company, San Francisco.
- JOHN HOOD, San Francisco engineer, General Electric Company, representing the manufacturers of electrical equipment, San Francisco.
- R. F. BEHAN, Westinghouse Electric & Mfg. Co., representing the manufacturers of electrical equipment, San Francisco.
- J. MORGENTHAUER, president Pacific District Council No. 1, International Brotherhood of Electrical Workers, San Francisco.
- C. A. ELMORE, president Cable Splicers Union No. 37, International Brotherhood of Electrical Workers, Oakland.
- HENRY BOYEN, Linemen's Union and Station Operators' Union No. 151, International Brotherhood of Electrical Workers, San Francisco.
- H. WARNER, Local Union No. 61, International Brotherhood of Electrical Workers, Los Angeles.
- WILLIAM L. RHYS, representing the International Vice-President of the International Brotherhood of Electrical Workers, San Francisco.
- J. F. POLLARD, gas and electrical department, State Railroad Commission, San Francisco.
- B. D. DEXTER, gas and electrical department, State Railroad Commission, San Francisco.
- R. L. ELTRINGHAM, electrical engineer, Industrial Accident Commission, San Francisco.
- JOHN R. BROWNELL (secretary), superintendent of safety, Industrial Accident Commission.

These Orders are based on the Electrical Stations section of the National Electrical Safety Code prepared by the United States Bureau of Standards, which was adopted with certain changes to meet local conditions and for purposes of abridgement.



## ELECTRICAL STATION SAFETY ORDERS.

### DEFINITIONS OF SPECIAL TERMS.

#### Order 1400.

The following definitions give the meanings of some of the terms occurring in these orders. Terms not defined will be understood to have their usual meanings.

(a) *Electrical supply equipment* means equipment which produces, modifies, regulates, controls, or safeguards a supply of electrical energy. Similar equipment, however, is not included where used in connection with signaling systems under the following conditions:

- (1) Where the voltage does not exceed 150.
- (2) Where the voltage is between 150 and 400 and the power transmitted does not exceed 3 kilowatts.

(b) *Electrical supply station* means any building, room, or separate inclosure within which is located electrical supply equipment and which is accessible as a rule only to properly authorized persons.

This includes generating stations and substations and generator, storage battery, and transformer rooms, but excludes manholes and isolated transformer vaults on private premises.

(c) *Electrical supply lines* means those conductors and their necessary supporting or containing structures which are located entirely outside of buildings and are used for transmitting a supply of electrical energy.

Does not include open wiring on buildings in yards or similar locations where spans are less than 20 feet, and all the precautions required for stations or utilization equipment, as the case may be, are observed.

Railway signal lines above 400 volts to ground are always supply lines within the meaning of these orders, and below 400 volts may be considered as supply lines, if so run and operated throughout.

(d) *Signal lines* means lines for public or private signal or communication service and devoted exclusively to the transmission of signals or intelligence, which operate at not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. Below 150 volts no limit is placed on the capacity of the system.

Telephone, telegraph, messenger-call, clock, fire, or police alarm, and other systems conforming with the above are included. Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so run. Signal lines not for public use coming under the above definition may be run and operated as supply lines if desired, and if consistently so run.

(e) *Utilization equipment* means equipment, devices, and connected wiring, which utilize electrical energy for mechanical, chemical, heating, lighting, testing, or similar purposes and are not a part of supply equipment, supply lines, or signal lines.

(f) *Voltage or volts* means the highest effective voltage between the conductors of the circuit concerned, except that in grounded multiwire circuits, not exceeding 750 volts between outer conductors, it means the highest effective voltage between any wire of the circuit and the ground.

In ungrounded, low-voltage circuits, voltage to ground means the voltage of the circuit.

When one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is permanently grounded. Direct connection implies electrical connection as distinguished from connection merely through electromagnetic or electrostatic induction.

(g) *Circuit* means a conductor or system of conductors through which an electric current is designed to flow, and connected equipment.

(h) *Grounded* means connected to earth or to some extended conducting body which serves instead of the earth, whether the connection is intentional or accidental.

(i) *Grounded system* means a system having a permanent and effective electrical connection to earth. This ground connection may be at one or more points.

"Effective," as herein used, means a connection to earth of sufficiently low impedance and high current-carrying capacity to prevent any current in the ground wire from causing a harmful voltage to exist between the grounded conductors and neighboring exposed conducting surfaces which are in good contact with the earth, or with neighboring surfaces of the earth itself, under the most severe conditions which are liable to arise in practice.

(j) *Permanently grounded* means such an effective connection to the earth (by use of an underground system of metallic pipe mains or other suitable means), as described in section (i).

(k) *Current-carrying part* means a part intended to be connected in an electric circuit to a source of electric supply. Noncurrent-carrying parts are those not intended to be so connected.

(*l*) *Alive or live* means electrically connected to a source of potential difference, or electrically charged so as to have a potential different from that of the earth. The term "live" is sometimes used in place of the term "current-carrying," where the intent is clear, to avoid repetitions of the longer term.

(*m*) *Dead* means free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth. The term is used only with reference to current-carrying parts which are sometimes alive.

(*n*) *Manual* means operated by personal intervention.

(*o*) *Automatic* means self-acting, operating by its own mechanism when actuated by some impersonal influence; as, for example, a change in current strength. Not manual, without personal intervention. Remote control that requires personal intervention is not automatic, but manual.

(*p*) *Cut-out* means any device, such as a fuse or circuit breaker, by which the electrical continuity of a conductor may be automatically broken by changes in current or voltage.

(*q*) *Circuit breaker* means a device designed to open a current-carrying circuit without injury to itself. A circuit breaker may be:

1. An automatic circuit breaker which is designed to trip automatically under any predetermined condition of the circuit, such as an underload or overload of current or voltage.

2. A manually tripped circuit breaker which is designed to be tripped by hand. Both types of operation may be combined in one and the same device.

(r) *Transformer* means a piece of stationary induction apparatus which changes electrical energy to electrical energy through the medium of magnetic energy, without mechanical motion.

A transformer may have but one coil, having parts of its turns connected to both the primary and secondary circuit—such as an auto-transformer. The most common form is the one in which the primary and secondary windings are insulated from each other, although a transformer may have any number of auxiliary windings.

(s) *Switch* means a device for opening or closing or changing the connection of a circuit manually. In these orders a switch will always be understood to be manually operated, unless otherwise stated.

(t) *Disconnecter* means any switch designed to isolate a piece of apparatus from an electrical source of supply. Disconnectors are not designed to open a circuit under load.

(u) *Substantial* means so constructed and arranged as to be of adequate strength and durability for the service to be performed under the prevailing conditions.

(v) *Qualified* or *authorized* means properly qualified or authorized to perform specified duties under the conditions existing.

(w) *Guarded* means covered, shielded, fenced, inclosed, or otherwise protected, by means of suitable covers or casings, barrier rails or screens, mats, or plat-

forms to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

(*x*) *Isolated* means that an object is not readily accessible to persons unless special means for access are used.

(*y*) *Isolation by elevation* means elevated sufficiently so that persons may safely walk underneath.

(*z*) *Exposed* means that an object or device can be inadvertently touched or approached nearer than a safe distance by any person. Objects not suitably guarded or isolated.

(*aa*) *Insulated* means separated from other conducting surfaces by a dielectric substance or air space permanently offering a high resistance to the passage of current and to disruptive discharge through the substance or space.

When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise, it is, within the purpose of these orders, uninsulated. Insulating covering of conductors is one means for making the conductors insulated.

(*ab*) *Insulating* (where applied to the covering of a conductor or to clothing, guards, rods, and other safety devices) means that a device, when interposed between a person and current-carrying parts, protects the person making use of it against electric shock from the current-carrying parts with which the device is intended to be used; the opposite of conducting.

(*ac*) *Explosion proof* (in locations where the presence of inflammable gas makes the atmosphere explosive in

character) means that an inclosure will withstand, without injury and without transmitting flame to the outside, any explosion of gas which may occur in the inclosure.

(ad) *Inclosed* (in locations where inflammable flyings, inflammable dust or explosives are present in dangerous quantities) means that an inclosure will not admit accumulations of flyings or dust, nor transmit sparks or flying particles to the accumulations outside.

(ae) *Conductor* means a metallic conducting material, usually in the form of a wire or cable, suitable for carrying an electric current. Does not include bus bars.

(af) *Bus Bar* means a main current-carrying conductor which receives the current from the supply source and is so arranged that feeders may be conveniently connected to it, forming a convenient connection between the supply source and the distribution system.

(ag) *Line conductor* means one of the wires or cables carrying electric current, supported by poles, towers, or other structures, but not including vertical or lateral connecting wires.

(ah) *Open lines* means overhead lines (not in conduits) consisting of single conductors or of individual twisted pairs, as distinguished from multiple conductor cables.

(ai) *Service* means the connecting conductors by which a supply of electrical energy is carried from a supply line to the building or premises served.

(aj) *Lateral conductor* means in pole wiring work, a wire or cable extending in a general horizontal direction approximately at right angles to the general direction of the line conductors.

(ak) *Vertical Conductor* in pole line construction means a conductor extending in the general vertical direction of the pole structure.

(al) *Normal sag* means the difference in elevation between the highest point of support of a span and the lowest point of the conductor in the span (or in the curve of the conductor in the span produced), at 60° F., with no wind loading.

(am) *Apparent sag of a span* means the departure of the wire in a given span from the straight line between the two points of support of the span at 60° F., with no wind loading. Where the two supports are at the same level this will be the normal sag.

(an) *Apparent sag at any point* means the departure of the wire at the particular point in the span from the straight line between the two points of support of the span, at 60° F., with no wind loading.

(ao) *Pole Face* means that side of a pole on which cross-arms are attached, or if such cross-arms are on both sides, that semicircumference which is so designated by the utilities owning or operating the pole.

(ap) *Climbing space* means the vertical space reserved along the side of a pole structure to permit ready access for linemen to equipment and lines located on the pole structure.



(aq) *Lateral working space* means the space reserved for working between conductor levels on either side of a pole, outside the climbing space.

(ar) *Conflicting or in conflict* (as applied to a pole line) means that the line is so situated with respect to a second line (except at crossings) that the overturning of the first line will result in contact between its poles or conductors and the conductors of the second line, assuming that no conductors are broken in either line: *Provided, however,* That lines on opposite sides of a highway, street or alley are not considered as conflicting if separated by a distance not less than 60% of the height of the taller pole line, but in no case less than 20 feet.

(as) *Duct* means (in underground work) a single runway for underground conductors.

(at) *Conduit* means (in underground work) a group of any number of ducts for underground conductors.

(au) *Manhole* (sometimes called a *splicing chamber* or *cable vault*) means an opening in an underground system which workmen or others may enter for the purpose of installing cables, transformers, junction boxes, and other devices, and for making connections and tests.

(av) *Handhole* means an opening in an underground system into which workmen reach but do not enter.

(aw) *Transformer vault* means an isolated, fireproof inclosure, either above or below ground, in which trans-

formers, and the devices necessary for their operation, are installed, and which is not continuously under attendance during operation.

(ax) *Reconstruction* means replacement of any portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

(ay) *Wire gages*: The American Wire Gage (A. W. G.), otherwise known as Brown & Sharpe (B. & S.), is the standard gage for copper, aluminum, and other conductors, excepting iron or steel, for which the Birmingham Wire Gage (B. W. G.) is used throughout these orders.

(az) *Switchboard* means a large single panel or assembly of panels on which are mounted (partly on the face and partly on the back) switches, fuses, busses, and usually instruments, and accessible both in front and in rear. Circuits and machinery of relatively large capacity are controlled from such boards.

(ba) *Panelboard* means a single panel containing busses, fuses, and switches to control lights, fan motors, and similar devices of small individual as well as aggregate capacity, placed in or against a wall or partition and accessible only from the front.

(bb) *Tags* means "men at work" tags of distinctive appearance, indicating that the equipment or lines so marked are being worked on.

**Order 1401.—Scope.**

(a) The following orders shall apply to all electrical supply stations and electrical supply equipment.

The Industrial Accident Commission reserves the right to modify these orders, to issue additional orders, and to issue special orders in particular cases as occasion may require.

**PROTECTIVE ARRANGEMENTS OF STATIONS OR SUBSTATIONS.**

**Order 1402.—Location of Electrical Supply Equipment.**

(a) Electrical Supply Equipment shall be installed in a suitable building, room or inclosure, which shall be accessible only to authorized persons.

**Order 1403.—General Requirements.**

All electrical supply stations shall comply with the following requirements:

(a) They shall be used neither for the storage of material nor for manufacturing processes, which may cause personal hazard.

(b) They shall be free from inflammable or explosive flyings and inflammable gas (excepting battery rooms). Indoor stations shall be dry and well ventilated.

(c) In outdoor stations or stations in wet tunnels or subways, all live parts of equipment shall be inclosed in weatherproof cases, unless the equipment is suitably designed to withstand the prevailing atmospheric conditions and the live parts are suitably guarded against contact, or isolated by elevation.

**Order 1404.—Illumination.**

(a) All electrical supply stations shall have adequate illumination. Arrangement of fixtures and plug receptacles shall be such that portable cords need not be brought into dangerous proximity to live electrical apparatus. All lamps shall be arranged to be controlled, replaced, or trimmed from, readily and safely accessible places.

(b) A separate emergency source of illumination, from an independent generator, storage battery, gas main, lanterns (the latter two shall not be used in battery rooms), or other suitable source, shall be provided in every station. Lanterns shall be maintained in fixed positions so chosen as to provide the necessary emergency illumination. Where an attendant is on duty within the station, lanterns and gas lights shall be kept lit during the hours of darkness. Emergency electric lights shall be kept burning during the hours of darkness, except in unattended storage battery rooms. Such lights shall be supplied from a separate emergency source, unless automatic means are provided to transfer them to the separate emergency source on failure of the normal source.

**Order 1405.—Inclosing Walls and Ceilings.**

(a) Electrical supply stations shall be so arranged with suitable fences, screens, partitions or walls, as to prevent entrance of unauthorized persons. Entrances not under observation of an authorized attendant shall

be kept locked. Signs prohibiting entrance to unauthorized persons shall be displayed at entrances.

(b) The minimum head room in electrical supply stations shall be 6 feet 6 inches.

Order 1406.—**Gears, Belts, Pulleys, Etc.; Ladders, Stairways, Floor Openings, Etc.; Engines, Boilers, Elevators, Etc.**

(a) In stations or substations, all gears, belts, pulleys, shafting, flywheels, movable ladders, stairways, platforms, runways, hoistways, floor openings, etc., shall be in compliance with the General Safety Orders of the Industrial Accident Commission. Engines, boilers, air pressure tanks, elevators, etc., shall be in compliance with the Safety Orders of the Industrial Accident Commission governing these several subjects.

(b) In stations or substations, all passageways (including stairways) and working spaces shall be unobstructed, and (except such as are used solely for infrequent inspection, construction and repair) shall provide at least 6 feet 6 inches headroom.

(c) In stations or substations, all stationary vertical ladders more than 20 feet high shall be equipped with safety loops.\*

(d) In stations or substations the upper ends of the side rails of permanent ladders shall be crooked, connected to horizontal railings or otherwise terminated so

---

\*It is recommended that the use of stationary vertical ladders should be discouraged and stairways used where practicable.

that the hands will not slip off the ends thereof, and suitable ladder landings shall be provided so that a person may attain the floors, roofs or platforms in an upright position.

**Order 1407.—Fire-Fighting Appliances.**

(a) Each electrical supply station where an operator is in attendance shall be provided with adequate approved fire-extinguishing appliances conveniently located and conspicuously marked. Any such appliances which have not been approved by the Underwriters' Laboratories for use on live parts shall be plainly and conspicuously marked with a warning to that effect.

**PROTECTIVE ARRANGEMENTS OF EQUIPMENT.**

**Order 1408.—Inspection.**

(a) Electrical supply equipment shall comply with these Orders when placed in service, and shall thereafter be periodically cleaned and inspected.

**Order 1409.—Protective Grounding.**

Where grounding is required as a permanent and effective measure as specified in these orders, it shall be done in accordance with the following methods:

(a) The ground conductor shall be of copper or other material which will not corrode excessively under the existing conditions.

(b) For grounding circuits or apparatus the ground conductor shall have a current capacity sufficient to

insure the continuity of the ground connections under conditions of excess current caused by accidental grounding of any normally ungrounded conductor of the circuit or apparatus.

(c) No individual ground conductor shall have less current capacity than that of a No. 6 copper wire.

**EXCEPTIONS:** Where additional grounds are attached after the first, smaller ground wires may be used, provided that they are in no case smaller than the conductor to which they are attached, nor smaller than No. 10 copper. Ground conductors from current and potential transformer circuits need not be greater than the circuits which they ground, but in no case less than No. 14 copper.

(d) Where exposed to mechanical injury the ground conductor shall be protected by substantial conduit or other approved guard.

(e) No automatic cut-out shall be inserted in the ground conductor or connection except in a ground connection from equipment where its operation will immediately result in the automatic disconnection from all sources of energy of the equipment so grounded; no switch shall be inserted, except in plain sight, and provided with distinctive marking.

(f) When possible, grounds shall be made to underground water piping systems, provided they furnish an effective ground, they shall be made on the street side of insulating joints or other devices which might interrupt the continuity of the underground pipe system.

(g) Where a suitable piping system is not available, effective artificial grounds may consist of driven pipes, buried plates, well casings, steel building frames or other devices which furnish the necessary conductivity.

(h) Ground wires shall be run separately to the ground (or to a grounding bus or system ground cable, which is well connected to ground at more than one place, and which is of sufficient capacity to carry the current which may arise from the failure of any of the circuits or apparatus connected thereto), for equipment and circuits of each of the following classes:

1. Lightning arresters.
2. Secondaries of low voltage lighting or power circuits.
3. Secondaries of current and potential transformers and instrument cases operating on circuits more than 500 volts between wires.
4. The neutral of 4-wire 3-phase systems.
5. Frames of d. c. railway equipment and equipment operating in excess of 750 volts.
6. Lightning arrester ground connections shall not be made to the same artificial ground (driven pipes or buried plates) as circuits or equipment, but shall be spaced as widely as practicable from other artificial grounds.

**Order 1410.—Working Space About Electrical Equipment.**

(a) Adequate working space with secure footing shall be maintained about all electrical supply equipment which requires adjustment or examination during operation. The working spaces shall be so arranged as to give the authorized attendants ready and safe access to



all parts requiring attention, inspection or repair. The working spaces shall afford a degree of safety not less than that provided by the minimum working spaces herein specified for the conditions most commonly encountered.

(b) The minimum widths of working spaces shall be:

1. Where there are exposed live parts not isolated by elevation (see Order 1412) on one side or on both sides of the working space:

Voltage	Minimum working space	Distance from working space to live parts	
		Live parts on one side only	Live parts on both sides
0-750 -----	30"	6"	12"
750-1,800 -----	36"	12"	22"
1,800-7,500 -----	36"	18"	22"
7,500-15,000 -----	36"	22"	22"
15,000-35,000 -----	36"	28"	28"
35,000-75,000 -----	36"	36"	36"
75,000-130,000 -----	36"	51"	51"
130,000-up -----	36"	63"	63"

The working space shall be defined by hand rails, the edges of compartments if not over 2 feet apart, bed frames of machinery, or other equally effective means designed to prevent inadvertent unsafe approach to the live parts, except that the working space need not be defined if the live parts are below 1,800 volts, are on one side only, and if no special hazard exists.

2. Where there are live parts on one or both sides of the working space not isolated by elevation but guarded

by barriers which must be removed for the inspection or adjustment of the live parts:

Voltage	Minimum working space	Distance from barrier to live parts
0-1,800	28"	2"
1,800-7,500	36"	3"
7,500-15,000	36"	4"
15,000-35,000	36"	10"
35,000-75,000	36"	18"
75,000-180,000	36"	33"
180,000-up	36"	45"

Where the distance from the barrier to the live part is less than six inches the barrier, if of wire mesh, shall not have a mesh greater than  $\frac{1}{2}$  inch; or, if of other material, shall not have any opening greater than  $\frac{1}{2}$  inch.

#### **Order 1411.—Guarding Live Parts.**

(a) Protection by the use of suitable guards or barriers shall be provided for persons against exposed ungrounded current carrying parts of electrical supply equipment (such as bus bars and other conductors, or the terminals of generators and motors) operating at over 300 volts to ground and not effectively isolated by elevation, except where these parts are away from passageways and working space used for construction, inspection and repair.

(b) If guards or barriers must be removed while the parts they guard are alive, suitable insulating platforms or mats shall be used.

Guards or barriers may consist of suitable casings or suitable insulating coverings. The continuous insulating coverings of con-

ductors should be depended upon only when it is impracticable to install more suitable guards, and then only when in every way adequate.

Where coverings, casings or barriers must at any time be removed from the otherwise exposed current-carrying parts which they guard, while these parts are alive, they should be of insulating material, or so arranged that they cannot readily be brought in contact with the live parts.

Mats made of wood held together by wood pins are recommended as the best. Cork matting, linoleum, or rubber may be used, but are not considered as good as wood mats.

(c) Inclosing or barrier guards not of grounded metal shall be of substantial material and spaced from current-carrying parts not less than three times the needle point sparking distance at the voltage concerned of the intervening air, oil or other dielectric.

(d) Bare parts of different potentials shall be effectively separated. Such parts in circuits operating at over 1,500 volts shall be provided with suitable barriers if liable to be short-circuited by tools or other conducting objects.

#### **Order 1412.—Isolating Live Parts by Elevation.**

(a) Live parts need not be guarded if they are maintained at the following elevations:

1. If the live parts are within inclosures which are only entered for the purpose of the inspection or the repair of the apparatus contained therein, such as switch compartments or transformer compartments.
2. If the live parts are over passageways commonly used by attendants for all purposes.

Voltage	Minimum elevation condition (a-1)	Minimum elevation condition (a-2)
0-1,800 -----	8'- 0"	14'- 0"
1,800-7,500 -----	8'- 2"	14'- 2"
7,500-15,000 -----	9'- 4"	14'- 4"
15,000-35,000 -----	8'-10"	14'-10"
35,000-75,000 -----	9'- 6"	15'- 6"
75,000-130,000 -----	10'- 9"	16'- 9"
130,000-up -----	11'- 9"	17'- 9"

**Order 1413.—Identification.**

(a) Electrical supply equipment shall be suitably identified when necessary for safety. The method of identification shall be uniform throughout any one system.

(b) The voltage and intended use shall be shown when important.

**STORAGE BATTERIES.**

The following Orders apply only to storage batteries exceeding 50 kilowatt hours capacity at the eight hour rate of discharge, and 150 volts to ground.

**Order 1414.—Isolation.**

(a) Storage batteries shall be made inaccessible to other than properly authorized persons by being placed in a separate room or inclosure.

**Order 1415.—Ventilation.**

(a) Rooms or inclosures containing storage batteries shall be so ventilated as to remove acid spray and prevent dangerous accumulation of inflammable gas.

Communication of drafts to other rooms should be prevented.

**Order 1416.—Suitable Supports and Floors.**

(a) The cells shall be supported by suitable insulators, except small cells, the containers of which are made of insulating material. Suitable drainage or other means shall be provided beneath cells to prevent the accumulation of electrolyte in case of leakage or spraying.

Acid-resistive floors, such as vitrified brick set in pitch, are recommended where large batteries are installed.

**Order 1417.—Guarding Live Parts in Battery Rooms.**

(a) The arrangement of cells and connections shall be such that no two current-carrying parts between which a voltage exceeding 150 exists, shall be closer than 3 feet, if the parts are so exposed that persons are liable to make accidental contact with both at the same time.

(b) No conductor shall be placed in any passageway, unless guarded or isolated.

**Order 1418.—Illumination.**

(a) Only incandescent electric lamps in keyless porcelain or composition sockets, or inclosed in moisture-proof globes, shall be used for the illumination of storage battery rooms. Switches controlling such lights shall be located outside the battery room. As the vapor in battery rooms is explosive under certain conditions, caution must be exercised in changing lamps to avoid a spark while so doing.

**Order 1419.—Acid-Resistive Coverings.**

(a) Conductors in battery rooms, if of such material or so located as to be liable to corrosion, shall have suitable protective coverings or coatings.

**TRANSFORMERS, REACTANCES, INDUCTION REGULATORS, BALANCE COILS, AND SIMILAR EQUIPMENT.****Order 1420.—Current Transformer Secondary Circuits.**

(a) Secondary circuits of current transformers (except those supplying relays only, or those having their primary circuits always disconnected before the secondary circuits are worked on), shall be provided with means for short-circuiting them which can be readily connected while the primary is energized, and which are so arranged as to permit the removal of any instrument or other device from such circuits without opening the circuits.

(b) Where primaries are above 7,500 volts, secondary circuits, unless otherwise adequately protected from injury or contact of persons, shall be in permanently grounded conduit.

**Order 1421.—Grounding Low-Voltage Circuits of Instrument Transformers.**

(a) The low-voltage circuits of all instrument transformers shall be permanently grounded unless the circuits are installed, guarded, and plainly identified as

required for the high-voltage circuits of the transformers.

This will sometimes require marking to distinguish such a low-voltage circuit from others with which it is associated, but which are protected by ground connections.

**Order 1422.—Grounding Transformer Cases.**

(a) The metal case or exposed frame of each transformer, reactance, and similar equipment, which is located where dampness or inflammable gas normally exists, or which is connected to a circuit operating at over 150 volts to ground, shall be permanently grounded.

Exception is permissible in locations free from inflammable gas, where the entire transformer is isolated or guarded as required for the highest voltage circuit connected with the transformer, and is plainly and conspicuously identified as of that voltage.

**Order 1423.—Methods of Transformer Installation.**

(a) Transformers shall be installed according to one of the three following methods:

1. On poles, in which case they must comply with the following:

Transformers, regulators and lightning arresters, when located below conductor or other attachments and less than five (5) inches from pole surface, shall be maintained on that side of the pole opposite to the climbing side, at that point.

On buckarm poles only the climbing space itself need be kept clear. The installation of transformers on buckarm poles should be discouraged.

When the conductors are to be worked upon alive, live parts of switches, automatic cutouts, and lightning arresters, if exceeding 300 volts to ground,

when on the climbing side of the pole, shall be inclosed or suitably guarded, if less than twenty (20) inches from the pole center, except when located on or above the top crossarm.

2. In transformer vaults, in which case they must be isolated and made inaccessible to unauthorized persons.
3. In buildings or inclosures, in which case the construction employed must comply with these Orders, as they may apply.

### **LIGHTNING ARRESTERS.**

#### **Order 1424.—Location.**

(a) Lightning arresters when installed inside of buildings shall be located as far as practicable from all other equipment and from combustible parts of the building.

#### **Order 1425.—Provisions for Disconnecting.**

(a) Lightning arresters on circuits over 7500 volts shall be so arranged, isolated, and equipped that they may be readily disconnected from conductors to which they are connected by air-break manual disconnectors, having air gaps of not less than four times the equivalent needle point sparking distance of the operating voltage of the circuit to which the arresters are connected, and never less than six inches. Such disconnectors, unless remotely controlled and operated, shall have the adjacent working spaces required by Order 1410 for disconnectors generally.



**Order 1426.—Ground Wires.**

(a) Ground wires shall be run as directly as possible and be of low impedance and ample current capacity and be otherwise installed in accordance with Order 1409.

**Order 1427.—Grounding Frames.**

(a) All noncurrent-carrying metal parts of arresters shall be grounded, unless effectively isolated by elevation, or guarded as required for live parts of the voltage of the circuit to which the arrester is connected, and suitably identified as of that voltage.

**Order 1428.—Guarding Live Parts.**

(a) All current-carrying parts of arresters on circuits above 750 volts, unless effectively isolated by elevation, shall be adequately guarded to protect persons from inadvertent contact with them, or from injury by arcing.

(b) Lightning arresters, unless provided with disconnectors which are always opened before work is done on the arresters, shall be so arranged that necessary adjustments are possible (without unsafe approach to parts which may become alive) through the use of permanently grounded mechanisms or suitable insulating appliances. Where charging or adjustments must be made with arresters alive, permanently grounded mechanisms or suitable insulating appliances shall always be provided.

## **CONDUCTORS.**

### **Order 1429.—Electrical Protection.**

(a) Conductors shall be suitable for the location, use and voltage, and (except grounded conductors, ground wires, and conductors of field circuits and of other circuits, the interruption of which may cause special hazard) shall be protected against excessive current by the design of the system, by the method of operation, or by suitable automatic cutout.

The protection of conductors by the method of operation as well as by design of the system refers particularly to the methods of operation of high tension transmission lines which do not permit automatic protection at the power house end of the main transmission circuits.

(b) Neutral conductors in three-wire systems shall be arranged without automatic cutouts interrupting their continuity, and without switches unless the switch opens all conductors of the circuit with one operation. In two-wire branches from three-wire circuits the conductor connected to the neutral is not considered a neutral conductor.

(c) All conductors grounded for the protection of persons shall be arranged without automatic cutouts interrupting their continuity between the source of electrical supply and the point to which the ground wire is attached. Switches shall either open all conductors of the circuit with one operation, or be placed only on the ungrounded conductors of the circuit.

**Order 1430.—Mechanical and Thermal Protection.**

(a) Where exposed to mechanical injury, suitable casing, armor, or other means shall be employed to prevent injury or disturbance to conductors, their insulation, or supports.

(b) Conductors with insulating coverings where closely grouped, as on the rear of switchboards or in cable ways, shall have a substantial non-combustible outer covering. Wiring to meters from shunts or from instrument transformers and other small wiring, if not over 300 volts to ground, shall be exempt from the requirements of this Order.

(c) Large uninsulated conductors liable to be torn from their supports by the stresses to which they are subjected (as by the magnetic fields produced) shall be so supported that they can not come in contact with the surfaces along which they are run or with other conductors.

**Order 1431.—Guarding Conductors.**

(a) Where insulated conductors are inclosed, suitable permanently grounded metal conduit or grounded metal sheathing shall be used; or in lieu thereof other ducts, runways, or compartments of tile, bitumenized fiber, concrete, or other suitable fire-resistive materials may be used, if containing no exposed combustible material. In damp places, conduit, ducts, or runways shall be made waterproof and be provided with suitable means for draining off condensation, unless the conductors contained are lead-sheathed.

(b) Conductors operating at over 750 volts (unless separately supported and effectively isolated by elevation or by inclosing in suitable compartments or screens, as in paragraph *d*) shall be suitably metal-sheathed, run in metal conduits or suitable fire-resistive ducts or compartments, with the metal sheathing permanently grounded. Other covering may be used in suitable grounded metal conduit or insulating duct, when installed in dry locations. The conduit or duct shall provide a smooth runway, with smooth outlets. Metal conduit, if used, shall be made electrically, and mechanically continuous with the metal casings of all conduit fittings.

(c) The insulation of conductor or conductors of metal-sheathed wires or cables on circuits above 750 volts, where leaving the metal sheath at outlets, shall be thoroughly protected from mechanical injury, moisture and electrical strains by means of a pot head or equivalent method.

(d) When any open insulated conductor above 750 volts, or any open bare conductor above 300 volts to ground, is necessarily brought closer to the floor line than the clearances required for isolation by elevation, they shall be guarded by permanent screens, by inclosing partitions, or by suitable barrier guards.

(e) Where barrier rails only are used, the surrounding floors shall be provided with suitable insulating platforms or mats, upon which an operator may stand. (See Order 1411.)

**Order 1432.—Guarding in Hazardous Locations.**

(a) Conductors in locations where inflammable gas normally exists shall be in metal conduit or metal-sheathed cable. All fittings and outlets of such conduit and cable shall be electrically and mechanically continuous with the conduit or metal sheath, and the conduit shall be sealed to prevent entrance of gases.

(b) Conductors in damp locations, if neither in conduit nor in waterproof metal sheaths in other suitable ducts, shall be effectively isolated and supported on a suitable type of insulator.

**Order 1433.—Pendants and Portables.**

(a) Pendant conductors shall not be installed where they can readily be moved so as to bring them in contact with live parts of electrical supply equipment.

(b) Portable conductors shall be attached to fixed wiring only through separable attachment plugs which will disconnect all poles by one operation.

**Order 1434.—Temporary Work.**

(a) Temporary work shall be permitted only for the purpose of making tests or for meeting emergencies. Such work shall be installed so as to afford a degree of safety to persons as near to that provided by these Orders as is practicable. The installation of permanent work to replace the temporary work shall be prosecuted with due diligence.

**Order 1435.—Taping Ends and Joints.**

(a) Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating covering with other portions of the conductor.

**FUSES AND OTHER CUT-OUTS; SWITCHES AND CONTROLLERS.****Order 1436.—Accessible and Indicating.**

(a) All switches, automatic cut-outs, starting rheostats, and other control devices shall be readily accessible to authorized persons. They shall be so arranged or marked as to identify the equipment controlled by them, and (except fuses) shall indicate whether they are open or closed. They shall be so installed as to minimize the danger of accidental operation. Such switches as may be closed by gravity shall be provided with a proper latch or stop block to prevent accidental closing. The blades of knife switches, except double throw switches, shall be dead when the switches are open, if the open blade presents a greater hazard than it would if closed.

**Order 1437.—Hazardous Locations.**

(a) In locations where explosives, inflammable gas or inflammable flyings normally exist in dangerous quantities, all parts at which sparking or arcing are liable to occur shall be so inclosed as to prevent hazard. (See Order 1456.)

**Order 1438.—Where Switches Are Required.**

(a) Suitable switches or cut-outs which may be manually operated shall be inserted in all leads (except a grounded conductor) to generators, motors, transformers (except instrument transformers), and all outgoing supply circuits, except that switches or cut-outs are not required in underground manholes or in transformer vaults.

In most cases the switch called for should be capable of opening the circuit under overloads. In some cases as between generators and transformer banks used with them, disconnectors only would be required.

Where two or more pieces of electrical supply equipment or supply lines are operated as a single unit no switch is necessarily required between them.

**Order 1439.—Switches for Disconnecting and Grounding Lines.**

(a) Switches shall be provided at electrical supply stations, which may be sources of power for disconnecting and short-circuiting and grounding all outgoing or incoming lines of 30,000 volts or above.

**Order 1440.—Character of Switches and Disconnectors.**

(a) Switches and disconnectors shall be of suitable voltage and ampere rating for the circuit on which they are installed.

(b) Remotely controlled switches, oil switches and disconnectors shall be so arranged that they can be secured or blocked in the open position and plainly tagged to prevent careless closing while work is being done on

equipment controlled by them, unless the switches are so constructed or installed as to prevent accidental closing or all live or moving parts of the equipment they control are so guarded as to render blocking and tagging unnecessary.

For switches and disconnectors the accidental opening of which may cause hazard, similar arrangements are desirable for retaining them in closed position.

Locking is recommended rather than blocking wherever parts of equipment are remote from the point of control.

(c) Air break switches or air break disconnectors shall be inserted between electrical supply equipment or lines and sources of energy supply of over 5,000 volts, if the equipment or lines must be worked on while the sources may be alive.

(d) Knife switches shall maintain such alignment under service conditions that they can be closed with a single unhesitating motion.

**Order 1441.—Where Automatic Cut-Outs Are Required.**

(a) All circuit leads to motors, transformers or other station auxiliaries shall be protected by suitable automatic cut-outs, except as provided in Order 1429, and except that where two or more pieces of electrical supply equipment or supply lines are operated as a single unit, no automatic cut-outs are required between them.



**Order 1442.—Disconnection of Fusible Cut-Outs Before Handling.**

(a) Fusible cut-outs which exceed 60 ampere capacity or which are in circuits operating at over 150 volts to ground, shall be arranged in one of the following ways:

1. So that the ungrounded current-carrying parts can not be touched by persons re-fusing the cut-outs until the fuses have been disconnected from all sources of electrical energy.
2. So that the cut-out can be disconnected by a suitable switch in series.
3. So that the fuse can be conveniently handled by means of insulating handles or portable appliances which must be provided for the purpose.

**Order 1443.—Arcing or Suddenly Moving Parts.**

(a) Fuses and circuit breakers shall, as far as possible, be so located and shielded that persons will not be burned by their operation.

(b) Handles or levers of circuit breakers and similar parts which may move suddenly, in such a way that persons in the vicinity are liable to be injured by being struck by them, shall be guarded or isolated.

**Order 1444.—Grounding Noncurrent-Carrying Metal Parts.**

(a) Exposed noncurrent-carrying metal parts of switch and fuse cases, levers and other similar parts to

which leakage is liable to occur from live parts, and thereby create a hazard, shall be permanently grounded according to the provisions of Order 1409. Minor parts, such as ferrules of knife switches, which are not liable to become alive, are excluded. Noncurrent-carrying metal tanks of oil switches which are insulated from the ground shall be treated as live parts of the voltage of the circuit to which the switch is connected.

**Order 1445.—Guarding Live Parts of Switches and Automatic Cut-Outs Not Installed on Switchboards or on Panel Boards.**

(a) All switches interrupting circuits over 750 volts shall be operated by means of remote control mechanisms, or be provided with suitable casings to protect the operator from danger of contact with current-carrying parts, except as provided for in paragraph (d) of this Order for switches or disconnectors requiring only infrequent attention. Devices to indicate the position of all switches shall be provided where the character of the control apparatus is such that the position of the switch would not otherwise be clearly indicated, except that position indicating devices will not be required on switches operated by floats, pressure governors or similar devices which may automatically close the switch. Such switches shall be so arranged that they may be locked open, or means shall be provided for disconnecting the apparatus controlled by such switches from all sources

of supply. All automatic cut-outs not isolated by elevation shall be of the inclosed type.

The control mechanism of large capacity high voltage oil switches should be so located that the operator will be safeguarded from possible failure of the oil switch when opened.

(b) All manual switches interrupting circuits under 750 volts shall have suitable casings or guards protecting the operator from danger of contact with current-carrying parts, effective during ordinary operation.

(c) Where live parts of switches or automatic cut-outs operating at over 300 volts to ground are not remotely controlled, or provided with inclosing guards effective during ordinary operation or adjustment, or isolated by elevation, suitable insulating floors, mats, or platforms shall be provided on which the operator must stand while operating the switches or adjusting the automatic cut-outs.

(d) Working space about occasionally exposed live parts shall be provided in accordance with Order 1410.

### **SWITCHBOARDS.**

#### **Order 1446.—Accessibility and Convenient Attendance.**

(a) Switchboards shall have all switches so arranged that the points of control are readily accessible to the operator. Instruments, relays, and other devices requiring reading or adjustment shall be so placed that work can be readily performed from the working space.

**Order 1447.—Location and Illumination.**

(a) Switchboards shall be so placed that the operator will not be endangered by any live or moving parts of machinery or equipment located near the board.

(b) Sufficient illumination shall be provided both for the front and rear of the switchboard so that the switchboard may be readily operated and instruments conveniently read.

**Order 1448.—Necessary Equipment.**

(a) Switchboards which control outgoing supply circuits shall (except in substations without regular attendance) be equipped with such instruments as are necessary to show operating conditions.

**Order 1449.—Arrangement and Identification.**

(a) Connections, wiring, and equipment of switchboards and panel boards shall be arranged in an orderly manner and all switches and cut-outs shall be plainly marked, labeled, or arranged so as to afford ready means for identifying circuits or equipment supplied through them.

**Order 1450.—Spacings and Barriers Against Short Circuit.**

(a) Switchboards shall have the number of bare parts at different potentials on any panel reduced to a minimum, and these parts shall be effectively separated.

Protection or separation of such parts by suitable barriers is recommended where the voltage exceeds 750.

It is recommended that such parts, including bus bars, should be so located, or provided with such insulating coverings or barriers, that parts at different potentials will not be readily short-circuited by tools or other conducting objects.

(b) Fuses shall be so located as to minimize the danger, in removing or replacing them, of short-circuiting parts at different potentials by the fuses or by the hands of the operator.

**Order 1451.—Grounding.**

(a) Switchboard frames shall be permanently grounded under the conditions and with the exceptions noted in Order 1409.

Exceptions: Switchboards—No ground connections need be made to exposed metal frames of switchboards on which all current-carrying parts operate at potentials not exceeding 750 volts to ground: provided that such frames are effectively insulated from the ground and that the switchboards are surrounded to an adequate distance by suitable insulating floors or platforms.

(b) Where protective grounds are occasionally required on circuits for the protection of workmen, a permanent ground connection shall be provided, and also suitable means for effectively and readily connecting the parts being grounded to the ground connection.

**Order 1452.—Guarding Live Parts.**

(a) All switchboards operating at over 300 volts to ground, and located near passageways, shall be guarded from these by suitable inclosures or barriers and shall (unless under constant attendance during operation) be made inaccessible to other than authorized persons.

(b) For the protection of the operator, where parts over 300 volts to ground are not otherwise guarded or

isolated by elevation, suitable insulating floors, mats, or platforms providing good footing shall be so placed that the operator can not readily touch the live parts, unless standing on such floors, mats, or platforms.

(c) No switchboard shall have exposed on its face within 6 feet from floor line any current-carrying part over 750 volts, except as noted in section (e) of this order, and excepting direct-current railway boards up to 1,500 volts, which, where above the nominal 750 volts, shall be so constructed that the operator can not inadvertently come in contact with parts having a hazardous difference of potential.

Dead face panels and remote control are recommended as means for accomplishing this result where isolation by elevation is impracticable or undesirable.

(d) When working space adjacent to live parts can not be provided in accordance with Order 1410, suitable guards shall be arranged to protect the operator from accidental contact with live parts.

(e) Plug-type switchboards shall, except while connections are being changed, have no current-carrying part exposed on face of boards and they and their plug connectors shall be so arranged where the operating voltage exceeds 300 as to have all current-carrying parts guarded so long as they are alive, even while connections are being changed.

(f) Metal cases of instruments (unless isolated by elevation) operating at over 750 volts shall be grounded or inclosed in suitable covers of insulating material or of grounded metal.

(g) No switchboard shall have current-carrying parts above 7,500 volts exposed (unguarded) unless these parts are effectively isolated by elevation, except at times when occasionally left exposed by removal of covers or entrance into inclosures, such as switch and instrument transformer cells or compartments, which are ordinarily unoccupied by persons. For such parts, if exposed while alive for any purpose (including busses and disconnectors in compartments), working space shall be provided complying with the requirements of Order 1410.

### **ROTATING EQUIPMENT.**

#### **Order 1453.—Speed Control and Stopping Devices.**

(a) Prime movers driving generating equipment shall be provided with automatic speed-limiting devices actuated by overspeed (in addition to their governors, if necessary, as with some types of turbines) where harmful overspeed can otherwise occur.

(b) Motor generators and converters of one k.w. capacity or larger, series motors, direct current generators, and separately excited direct current motors where it is possible for them to be driven at an excessive speed from the direct current end by a reversal of current or decrease of load, shall be provided with speed limiting devices actuated by overspeed, unless the load and the mechanical connections thereto are of such a character as to safely limit the speed.

(c) Where the speed control of direct-current motors is accomplished by varying the field resistance, and the nature of the load and the range of the field rheostat are such as to make a dangerous speed attainable and no speed-limit devices are used, the field rheostats shall be arranged with no-voltage releases or other devices so that the motor can not be started or continued in operation under dangerously weakened field.

(d) Stopping devices, such as switches or valves which can be operated from locations convenient to operators, shall be provided for prime movers or motors driving generating equipment.

(e) Where speed limiting or stopping devices are electrically operated, the control circuits by which such devices are actuated shall be in conduit or otherwise suitably protected from mechanical injury.

**Order 1454.—Protecting Shaft Ends, Pulleys, Belts, and Other Moving Parts.**

(a) Suitable guards or inclosures shall be arranged at each motor or generator when necessary to prevent persons or objects from inadvertently coming in harmful contact with moving parts.

**Order 1455.—Guards for Live Parts.**

(a) Suitable insulating floors, mats or platforms of substantial construction, and providing good footing, shall be so placed on floors, and, if necessary, on frames of machines having exposed live parts above 300 volts



to ground, that operators can not readily touch such parts unless standing on the mats or platforms.

(b) Steps and hand rails shall be installed on or about large machines where necessary to afford ready and safe access to live or other parts which must be examined or adjusted during operation.

(c) Where switches are installed on the frames of generating equipment for the purpose of reducing inductive voltage in generator and converter field coils, they shall be suitably constructed or guarded to prevent passers-by from inadvertently coming in contact with the live parts, to protect persons handling them, and to prevent their being accidentally opened or closed.

(d) Suitable shields or barriers shall be provided where necessary to prevent arcs from large commutators or circuit breakers from injuring persons in the vicinity, as in the case of narrow switchboard galleries or similar working spaces located immediately above or beside such equipment.

**Order 1456.—Hazardous Locations.**

(a) In locations where explosives, inflammable gas or inflammable flyings normally exist in dangerous quantities, all parts at which sparking or arcing are liable to occur shall be so inclosed as to reduce the hazard as far as practicable.

This inclosure shall be by one of the following methods:

1. By placing in separate compartments or rooms.
2. By using casings of the inclosed type when inflammable dust or flyings are present.
3. By using explosion-proof casings when inflammable gases exist in dangerous quantities.

(b) All casings shall be nonabsorptive and noncombustible, and when of metal shall be permanently grounded if within reach of grounded surfaces.

**Order 1457.—Grounding Noncurrent-Carrying Parts.**

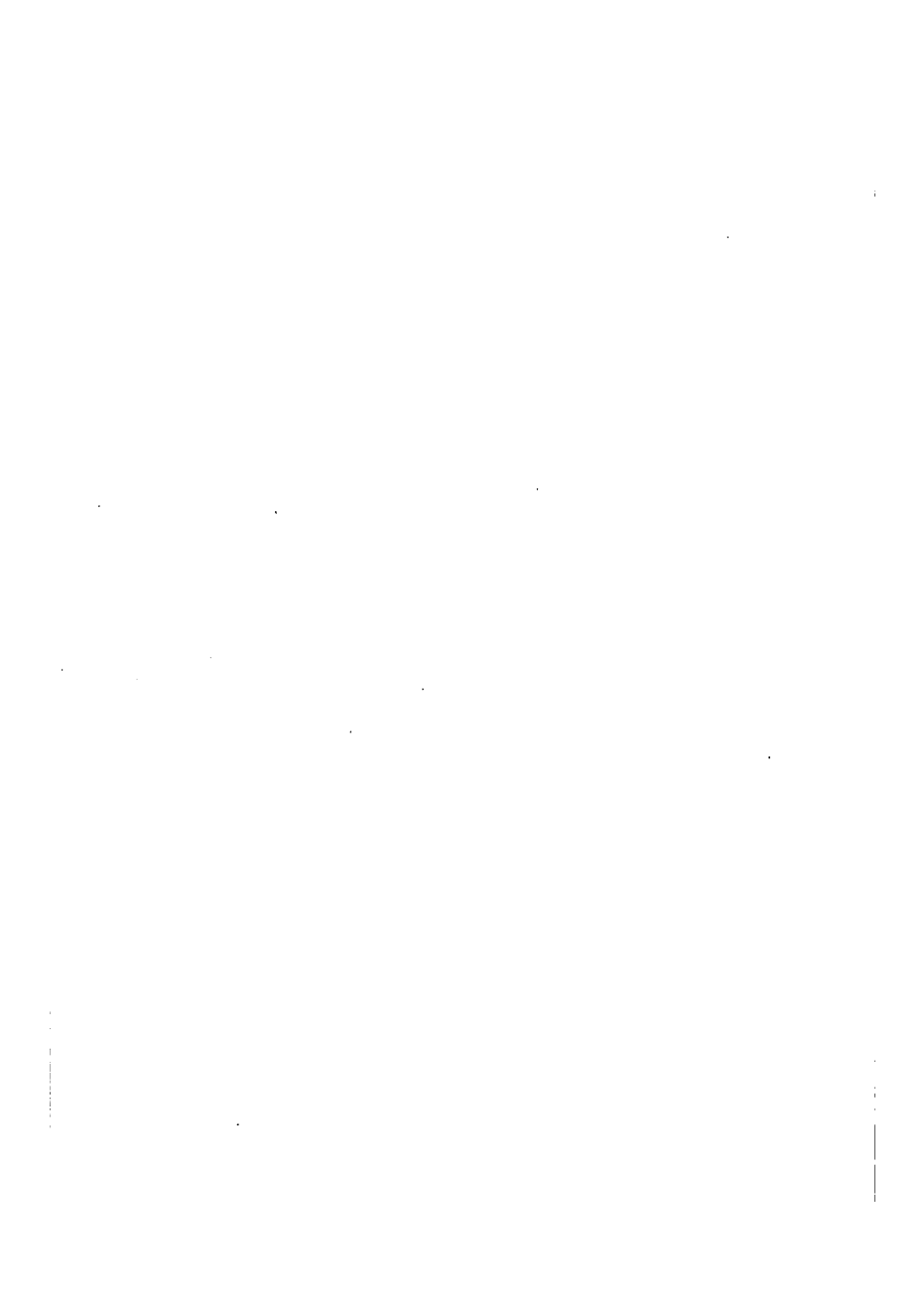
(a) All exposed noncurrent-carrying metal parts of rotating electrical supply equipment shall be permanently grounded in accordance with the requirements for grounding provided in Order 1409, except as follows:

1. Where machine frames such as those of series are light generators or direct-current railway generators are necessarily ungrounded, suitable insulating floors, mats, or platforms providing good footing shall be so placed that no person can readily touch the machine frame unless standing on such floor, mat, or platform.
2. Where two or more machines, either of which operates at over 150 volts to ground, are mechanically coupled together and the operator can touch the frames of more than one at a time, the frames of all such shall be bonded together electrically, or permanently grounded.

(b) Exciters and auxiliary circuits electrically connected to generators or other machines with frames ungrounded, and operating at over 750 volts to ground, shall be installed, protected and identified as machines and circuits of the same voltage as that of the machine for which they are auxiliaries.

**Order 1458.—Deteriorating Agencies.**

(a) Suitable guards or inclosures shall be provided to protect exposed current-carrying parts, insulation of leads, balance coils, or other electrical devices belonging to motors and generating equipment where installed directly under equipment or in other locations where dripping oil, excessive moisture, steam, vapors, or similar injurious agents exist. The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be permanently grounded.



# INDEX.

## A

	Page	Order	Subdi- vision
Accessibility, of or to			
Switchboards .....	39	1446	a
Switches, etc. ....	34	1436	a
Acid-resistive coverings, storage batteries.....	26	1419	a
Alive, or live, definition of.....	8	1400	1
Apparent sag of span, definition of.....	12	1400	am, an
Arcing or suddenly moving parts.....	37	1443	a, b
Arrangement of switchboards.....	40	1449	a
Automatic, definition of.....	8	1400	o

## B

Barriers against short circuit on switchboard.....	40	1450	a, b
Bus bar, definition of.....	11	1400	af

## C

Circuit, definition of.....	7	1400	g
Circuit breaker, definition of.....	8	1400	q
Climbing space, definition of.....	12	1400	ap
Conductors (general) .....	30-34	1429-1435	--
Definitions of .....	11	1400	ae
Electrical protection .....	30	1429	a
Guarding.			
Conductors .....	31-32	1431	a-e
In damp and hazardous locations.....	33	1432	a, b
Mechanical and thermal protection.....	31	1430	a-c
Pendants and portables.....	33	1433	a, b
Taping ends and joints.....	34	1435	a
Temporary work .....	33	1434	a
Conduits.			
Definition of .....	13	1400	at
Conflicting, definition of.....	13	1400	ar
Current-carrying part, definition of.....	7	1400	k
Current transformers, secondary circuits.....	26	1420	a, b
Cutout, definition of.....	8	1400	p
Cutouts. See Switches.			

## D

Damp locations, guarding of conductors in.....	33	1432	b
Dead, definition of.....	8	1400	m
Definitions of special terms.....	5-14	1400	a-bb
Deteriorating agencies on rotating equipment.....	47	1458	a
Disconnecting fusible cutouts before handling.....	37	1442	a
Disconnecting, provisions for, of arresters.....	28	1425	a
Disconnector, definition of.....	9	1400	t
Duct, definition of.....	13	1400	as

E			
	Page	Order	Subdi- vision
Electrical protection of conductors.....	30	1429	a-c
Electrical supply.			
Equipment, definition of.....	5	1400	a
Lines, definition of.....	5	1400	c
Station, definition of.....	5	1400	b
Explosion proof, definition of.....	10	1400	ac
Exposed, definition of.....	10	1400	z
F			
Fire fighting appliances.....	18	1407	a
Floors, suitable for storage batteries.....	25	1416	a
Frames, grounding of, on switchboards.....	41	1451	a
Fuses. See Switches.			
Fusible cutouts, disconnection of.....	37	1442	a
G			
Gears, belts, pulleys, ladders, stairways, floor open- ings, engines, boilers, elevators, etc.....	17	1406	a-d
General requirements of electrical supply stations..	15	1403	a-c
Ground wires of lightning arresters.....	29	1423	a
Grounded.			
Definition of .....	7	1400	h
Permanently, definition of.....	7	1400	j
System, definition of.....	7	1400	i
Grounding.			
Frames of lightning arresters.....	29	1427	a
Frames of switchboards.....	41	1451	a, b
Low voltage circuits of instrument transform- ers .....	23	1421	a
Noncurrent carrying parts of fuses, switches, etc..	37	1444	a
Protective grounding .....	18-20	1409	a-h
Rotating equipment .....	46-47	1457	a, b
Switches, etc. ....	35	1439	a
Transformer cases .....	27	1422	a
Guarded, definition of.....	9	1400	w
Guarding.			
Conductors (general) .....	31-32	1431	a-e
Conductors in damp or hazardous places.....	33	1432	a, b
Live parts of			
Electrical supply equipment.....	22-23	1411	a-d
Lightning arresters .....	29	1428	a, b
Rotating equipment .....	44-45	1455	a-d
Storage battery rooms.....	25	1417	a, b
Switchboards .....	41-43	1452	a-g
Switches, etc. ....	38-39	1445	a-d
Methods of transformer installation.....	27-28	1423	a

# Index.

51

H			
	Page	Order	Subdi- vision
Handhole, definition of.....	13	1400	av
Hazardous locations.			
Guarding conductor in.....	33	1432	a, b
Rotating equipment .....	45-46	1456	a, b
Switches, etc. ....	34	1437	a
I			
Identification of			
Switchboards .....	40	1449	a
Illumination of			
Electrical supply stations.....	16	1404	a, b
Storage battery rooms.....	25	1418	a
Switchboards .....	40	1447	b
Inclosed, definition of.....	11	1400	ad
Inclosing walls and ceilings of electrical supply stations .....	16-17	1405	a, b
Inspections of electrical supply equipment.....	18	1408	a
Installing transformers .....	27-28	1423	a
Insulated, definition of.....	10	1400	aa
Insulating, definition of.....	10	1400	ab
Isolated, definition of.....	10	1400	x
Isolation by elevation, definition of.....	10	1400	y
Isolating or isolation of			
Live parts of electrical supply equipment.....	23	1412	a
Storage batteries .....	24	1414	a
L			
Lateral conductor, definition of.....	12	1400	aj
Lateral working space, definition of.....	13	1400	aq
Lightning arresters .....	28-29	1424-1428	--
Ground wires .....	29	1426	a
Grounding frames .....	29	1427	a
Guarding live parts.....	29	1428	a, b
Location .....	28	1424	a
Provisions for disconnecting.....	28	1425	a
Line conductor, definition of.....	11	1400	ag
Live, definition of.....	8	1400	l
Location of electrical supply equipment.....	15	1402	a
Location of lightning arresters.....	28	1424	z
Location of switchboards.....	40	1447	a
M			
Manhole, definition of.....	13	1400	au
Manual, definition of.....	8	1400	n
Mechanical and thermal protection of conductors.....	31	1430	a-c

<b>N</b>			
	Page	Order	Subdi- vision
Normal sag, definition of.....	12	1400	al
<b>O</b>			
Open lines, definition of.....	11	1400	ah
<b>P</b>			
Panelboard, definition of.....	14	1400	ba
Pendants and portables.....	33	1433	a, b
Permanently grounded, definition of.....	7	1400	j
Pole face, definition of.....	12	1400	ao
Portables.....	33	1433	b
Protecting shaft ends and other moving parts of rotating equipment.....	44	1454	a
Protective arrangements of equipment.....	18-24	1408-1413	--
Guarding live parts.....	22-23	1411	a-d
Identification.....	24	1413	a, b
Inspection.....	18	1408	a
Isolating live parts by elevation.....	23	1412	a
Protective grounding.....	18-20	1409	a-h
Working space about electrical equipment.....	20-22	1410	a, b
Protective arrangements of stations or substations.....	15-18	1402-1407	--
Fire fighting appliances.....	18	1407	a
Gears, belts, pulleys, etc.; ladders, stairways, floor openings, etc.; engines, boilers, eleva- tors, etc. ....	17	1406	a-d
General requirements.....	15	1408	a-c
Illumination.....	16	1404	a, b
Inclosing walls and ceilings.....	16-17	1405	a, b
Location of electrical supply equipment.....	15	1402	a
Provisions for disconnecting lightning arresters....	28	1425	a
<b>Q</b>			
Qualified or authorized, definition of.....	9	1400	v
<b>R</b>			
Reconstructions, definition of.....	14	1400	ax
Rotating equipment.....	43-47	1453-1458	--
Deteriorating agencies.....	47	1458	a
Grounding noncurrent-carrying parts.....	46-47	1457	a, b
Guards for live parts.....	44-45	1455	a-d
Hazardous locations.....	45-46	1456	a, b
Protecting shaft ends, pulleys, belts and other moving parts.....	44	1454	a
Speed control and stopping devices.....	43-44	1453	a-e



S		Page	Order	Subdi- vision
Sag, definitions of.....	12	1400	al-an	
Scope .....	15	1401	a	
Service, definition of.....	11	1400	ai	
Signal lines, definition of.....	6	1400	d	
Spacings on switchboards.....	40-41	1450	a, b	
Special terms, definitions of.....	5-14	1400	a-bb	
Speed control and stopping devices of rotating equipment .....	43-44	1453	a-e	
Storage batteries .....	24-26	1414-1419	--	
Acid resistive coverings.....	26	1419	a	
Guarding live parts.....	25	1417	a, b	
Illumination in battery rooms.....	25	1418	a	
Isolation .....	24	1414	a	
Suitable supports and floors.....	25	1416	a	
Ventilation .....	24	1415	a	
Substantial, definition of.....	9	1400	u	
Supply.				
Equipment, electrical, definition of.....	5	1400	a	
Lines, electrical, definition of.....	5	1400	c	
Station, electrical, definition of.....	5	1400	b	
Supports and floors suitable for storage batteries.....	25	1416	a	
Switch, definition of.....	9	1400	s	
Switchboards .....	39-43	1446-1452	--	
Accessibility and convenient attendance.....	39	1446	a	
Arrangement and identification.....	40	1449	a	
Definition .....	14	1400	az	
Grounding .....	41	1451	a, b	
Guarding live parts.....	41-43	1452	a-g	
Illumination .....	40	1447	b	
Location .....	40	1447	a	
Necessary equipment .....	40	1448	a	
Spacings and barriers against short circuit.....	40-41	1450	a, b	
Switches, fuses and other cutouts, control and other similar devices.....	34-39	1436-1445	--	
Accessible and indicating.....	34	1436	a	
Arcing of suddenly moving parts.....	37	1443	a, b	
Character of switches and disconnectors.....	35-36	1440	a-d	
Disconnection of fusible cutouts before handling.....	37	1442	a	
Grounding noncurrent-carrying metal parts.....	37	1444	a	
Guarding live parts of switches and automatic cutouts not installed on switchboards or on panel boards .....	38-39	1445	a-d	
Hazardous locations .....	34	1437	a	
Switches for disconnecting and grounding lines.....	35	1439	a	
Where automatic cutouts are required.....	36	1441	a	
Where switches are required.....	35	1438	a	





3 9015 06395 0730